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Structure design and establishment of database application system for alien species in Shandong Province, China

GUO Wei-hua^{1,2}, LIU Heng¹, DU Ning¹, ZHANG Xin-shi^{1,2,3}, WANG Ren-qing*¹¹ College of Life Sciences, Shandong University, Jinan 250100, P. R. China² Key Laboratory of Environmental Change and Natural Disaster of Ministry of Education, Beijing Normal University, Beijing 100875, P. R. China³ Laboratory of Quantitative Vegetation Ecology, Institute of Botany, Chinese Academy of Sciences, Beijing 100093, P. R. China

Abstract: This paper presents a case study on structure design and establishment of database application system for alien species in Shandong Province, integrating with Geographic Information System, computer network, and database technology to the research of alien species. The modules of alien species database, including classified data input, statistics and analysis, species pictures and distribution maps, and out date input, were approached by Visual Studio.net 2003 and Microsoft SQL server 2000. The alien species information contains the information of classification, species distinction characteristics, biological characteristics, original area, distribution area, the entering fashion and route, invasion time, invasion reason, interaction with the endemic species, growth state, danger state and spatial information, i.e. distribution map. Based on the above bases, several models including application, checking, modifying, printing, adding and returning models were developed. Furthermore, through the establishment of index tables and index maps, we can also spatially query the data like picture, text and GIS map data. This research established the technological platform of sharing information about scientific resource of alien species in Shandong Province, offering the basis for the dynamic inquiry of alien species, the warning technology of prevention and the fast reaction system. The database application system possessed the principles of good practicability, friendly user interface and convenient usage. It can supply full and accurate information inquiry services of alien species for the users and provide functions of dynamically managing the database for the administrator.

Keywords: Alien species; Database application system; Distribution map; SQL Server; Visual Studio.net; Shandong Province

Introduction

Shandong Province becomes a susceptible area of alien species introduction and spread, due to a long introduction history, developed agriculture and convenient traffic. Alien species in Shandong Province estimate to 500 kinds approximately, a great deal of them is harmful to a certainty. There are 8~10 species among 16 kinds of which announced to be invasive alien species by our country.

Some study indicates that invasive alien species is the second largest threat to the global bio-diversity, which is the greatest threat to some island ecosystem too, because the influence of

IAS has caused a large number of economic losses (Li *et al.* 2000; Pimentel *et al.* 2005; Rejmanek *et al.* 1996; Species Survival Commission, 2000; Simberloff 1996; Stachowicz *et al.* 1999; Wilcove *et al.* 1998). Invasive alien species has already done a great harm to the ecosystems and bio-diversity of Shandong Province, of which the most famous one is the *Matsucoccus matsumurae* from Japan introduced in the fifties, they destroyed *Pinus densiflora* of Shandong Peninsula almost entirely. Recently, *Bursaphelenchus xylophilus*, *alterniflora* Loifel, etc. had done a great harm to agriculture, forestry, fishery and feeding in Shandong Province. Hence it is very essential and urgent to do the relevant research as soon as possible. However, there is still a lack of these kinds' research reports in Shandong Province (Chen *et al.* 2002; Liu *et al.* 2001; Shan 2002; Tian *et al.* 2004).

Database techniques have been applied widely in the relevant researches in recent years, such as the Global Alien Species Database, Website: <http://www.issg.org/database/welcome>; China Species Information Services, Website: <http://www.chinabiodiversity.com/search/searchwwf.shtm>; The Chinese Sustainable Development Information Network, Website: <http://sdinfo.forestry.ac.cn/sjkzl.cfm>. All of these provide good basis for our study.

This paper presents a case study on structure design and establishment of database application system for alien species in Shandong Province, integrating with GIS (Geographic Information System), computer network and database technology to the research of alien species, in order to keep the scattered materials in order and supplements systematically in the form of database, standardize the management of alien species information in Shandong Province, establish the technological platform of sharing information about scientific resource of alien species in

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Biography: GUO Wei-hua (1968-), female, Ph. D., Associate Professor in College of Life Sciences, Shandong University, Jinan 250100, P. R. China.

Email: guo_wh@yahoo.com

*Corresponding author: WANG Rui-qing : Email: wrq@sdu.edu.cn

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Shandong Province, offer the basic basis for the dynamic inquiry of mainly alien species.

Methods and technique route

Investigation of original information in the database

Information consultation and network investigation: the systemic analysis for the alien species were carried through searching network and the literature; and then, some information of alien species in Shandong Province which has existed and alien species situation which had been confirmed in other areas were obtained.

Open country investigation: the goal species' information including invasion time, the reason, the distribution area, grow and harm situation at present, biology characteristic, population quantity tendency and its control factor of main harm type were obtained by open country investigation and also by expert advisory meetings; and at the same time, typical pictures were collected and GPS positions of main alien species were localized.

Cataloging and map protraction: catalog of alien species in Shandong Province was established on the basis of surface investigation and information analysis; thereafter, the distribution and disserved charts of alien species in Shandong Province were drawn up through GIS and GPS technology.

Database establishment: the catalog information of alien species in Shandong Province were hyperlinks up with the distribution and disserved chart of alien species in Shandong Province; and then real-time transmission and Internet inquiries were realized after debugging.

Database technology

The database we usually said actually is the database system for short. The database system is a complete system; the database-stored datum is a constituent merely. The database stores datum, the application system uses the datum, the management system manages the datum, and these three complement one another.

The small database product like FoxPro, Access is called tabletop database, its main characteristic is that it is applied in the stand-alone environment, does not need the support of network operating system, does not provide or provides the limited network application function merely, has not or only has the weak secure precept. The purpose to design these types of database to manage the systems is to satisfy small daily work, therefore the tabletop database system provides the weak data bank administration and the strong front developing instrument. The developing kit and the database integrate to a body. It is not only the data bank administration tool, but also is the database application and front developing instrument, for example, there is application developing kit integrated in Visual FoxPro 6.0, script language integrated in Access97 and 2,000. Therefore, the tabletop database works in the stand-alone environment, stresses on the feasibility, easy to exploit, simple management and so on.

Compared with the traditional tabletop database, the large-scale network data base products with SQL Server series of Microsoft Company (Shan 2002), DB2 series of IBM, Sybase series of Sybase Company and Oracle 9i of Oracle Company, etc. have the following main characteristics:

1. Need the operating system of the network to support, in-

cluding Windows NT Server, Windows 2000 Server, Windows 2003 Server, Linux Server, UNIX, etc.

2. Database system management tools, front developing instrument and background database can be separated; the network database management system, which means the total of management tools and background database.

3. Strong network functions and distributed function can make up into various kinds of work patterns according to the different of software and hardware and the environment of the network.

4. Modern techniques, support super large-scale database technology, abreast inquire, many thread server, etc.

5. Complete data security scheme, perfect backup and resume means of the database.

Design of the database

The method of the design of database varies with concrete database, but modeling stage is the same: according to the demand of system, draw support from E-R picture, obtain and analyze application system message which want to be realized mainly in this stages, carry through the analysis of internal the data and external relation, lead out the initial relation mode, then use the standardized theory, lead out the rational data model. On this basis, we must also estimate to analyze the data amount of the database, the flow of the data and response speed, design the reasonable database synthetically considered of the function, security, convenient management, easy of developing etc. of the database. In order to realize optimum function in the nicer SQL Server scheme, the most key is to have a very good design plan of database considered from the aspects of database logical design and physical design.

Categorized method

Because the definition of alien species and principle categorized are different, the classification is not the same, it can be divided into the alien plant, alien animal, alien microorganism; According to the introduction way of alien species, it can be divided into intentional introduced species: the species releases and settles down in wild area by people on purpose, unintentional introduced species: the species is introduced to the new ecosystem unintentionally because of human activity, including it is introduced on purpose for raising, but escapes to wild state, man-made species: new species or mutation species manufactured by the genetic engineering or other artificial breeding.

According to the harm extent of alien species, it is divided into general alien species, potential harmful alien species and harmful alien species. Potential harmful alien species mean that it has not done harm at present, but it maybe dangerous to native species if the introduction is incorrect.

System environment

Development environment

Visual Studio.net 2003 + Microsoft SQL server 2000. Visual Studio. NET is an set of developing instruments, used for producing ASP Web application procedure, XML Web services, desk-top application procedure and moving application procedure. Visual Basic.NET, Visual C++.NET, Visual C#.NET and Visual J#.NET all use the same integrated development environment (IDE), this environment allows them to share the tool and to be helpful to the foundation of mix language solution.

Moreover, these languages have used the function of NET Framework, this frame provides the visit to simplify the ASP Web application procedure and the key technology of XML Web services development. SQL Server 2000 is the main center of data management and analysis of Microsoft.NET Enterprise Server. SQL Server 2000 includes the acceleration tool which has the function from the concept to finally, the service of integration and may expand. SQL Server 2000 establishes the end-to-end analysis solution including integrated tools, and creates value from data. In addition, it has an automatic actuation commercial process and can nimbly retrieved self- definition result from the most complex computation, it has a function of fast development, debugging and data conversion. SQL Server 2000 has the function of interactive adjustment and the debugging inquiry, rapid traverse and transform data from any data pool, as well as according the Transact-SQL way to definite and use the function etc. It may design and compile the database application procedure from willful Visual Studio tool by visible way.

Server environment

Windows server family+ NET Framework. NET Framework is the programming model used to the NET platform. The essential module of NET Framework is the common language running storehouse and NET Framework kind of storehouse (including ADO.NET, ASP.NET and Windows body). NET Framework provides entrusted execution environment, the simplification development and deployment, as well as integration of each kind of programming language. NET Framework is the internal windows module supported the production and running next generation application procedure and the XML Web services. NET Framework is for the purpose of achieving the following goal: Provides a consistent object-oriented programming environment, regardless of the object code is saved and executed in local, or carries out in local but distributes on Internet, or executed in the long-distance. It provides a code execution environment, which the software deployment and the edition control conflict are

smallest. It provides a code execution environment, which is possible to enhance the code (including the code which is unknown or founded by the third party incompletely trusted) executive security.

User environment

Windows series+ Internet Explorer 6.0. Internet Explorer is the Web browser which in Windows sets, more than 80% PC in the world has installed this browser in advance, IE6.0 is its newest edition, which has strongly function and highly security. Therefore this system has the very broad applicable scope.

Structure design of the database

The table structure of database preliminary establishment stage is extremely simple; there is no need to introduce the complex content like index trigger, which strengthened the probability and the usability of the database. The concrete design is as follows:

One table (wzxx), including Chinese systematic name (zwxm), Latin name (ldwm), Chinese Division name (zwmm), Latin Division name (ldmm), Chinese Class name (zwgm), Latin Class name (ldgm), Chinese Order name (zwmum), Latin Order name (ldmum), Chinese Family name (zwkm), Latin Family name (ldkm), Chinese Genus name (zwsn), Latin Genus name (lds), Latin Species name (ldzm), synonym (ym), Chinese common name (zwsun), English common name (ywsun), species type (lx), human name who named the species (namer), naming age (nd), shape characteristic (xttz), biology characteristic (swtz), host scope (jzfw), harm situation (whqk), dissemination way (cbtj), abroad distribute (jwfb), China distribute (zgfb), Shandong distribute (sdfb), distinction method (jbff), preventing and controlling methods (fzjs), serial number (sid), edition time (lastedit_time) etc, 31 fields in all.

Establishing Chinese systematic name for the key words cannot duplicate, sid is the species serial number which is established as the automatic growth, these two fields cannot for be vacant, which has determined the content cannot repeat.

列名	数据类型	长度	允许空	列名	数据类型	长度	允许空
sid	int	4		ywsun	nvarchar	255	✓
zwxm	nvarchar	255		namer	nvarchar	255	✓
ldwm	nvarchar	255	✓	nd	char	4	✓
zwmm	nvarchar	50	✓	lx	nvarchar	50	✓
ldmm	nvarchar	50	✓	xttz	ntext	16	✓
zwgm	nvarchar	50	✓	swtz	ntext	16	✓
ldgm	nvarchar	50	✓	jzfw	ntext	16	✓
zwmum	nvarchar	255	✓	whqk	ntext	16	✓
ldmum	nvarchar	255	✓	cbtj	ntext	16	✓
zwkm	nvarchar	255	✓	jwfb	ntext	16	✓
ldkm	nvarchar	255	✓	zgfb	ntext	16	✓
zwsn	nvarchar	255	✓	sdfb	ntext	16	✓
lds	nvarchar	255	✓	jbff	ntext	16	✓
ldzm	nvarchar	50	✓	fzjs	ntext	16	✓
ym	ntext	16	✓	lastedit_time	datetime	8	✓
zwsun	nvarchar	255	✓				

Fig.1 Field definition

Design of the user interface

According to the request of design, it needs to realize the func-

tion of browsing, retrieval inquiry, increase and revision and so on. Designed home page (default.aspx) to realize browsing database function, search.aspx to realize search movement,

search-result.aspx to realize search result feedback, browser.aspx to realize demonstration of species information, imageshow.aspx to realize picture demonstration and zoom function, add.aspx to realize the function to increase species information, modify.aspx to realize species information revision function. These designs incarnate the five models including checking, modifying, printing, adding and returning adequately.

Because the content of page eyebrow and page foot is fixed, they do not need for producing the page many times in the browsing process, we design two templates modules, i.e. Header.ascx and footer.ascx to save the server system resources and speed up the user browsing speed. Glances over the complete content is equal to search unconditionally, therefore it can use a common template module, i.e. search-result.ascx with the search result contact surface.

Design of database movement

Microsoft's ADO.net technology has provided the consistent visit to Microsoft SQL Server data pool as well as data pool made public through OLE DB and XML. The data-sharing user can use ADO.NET to connect these data pools, and retrieve, operate and renew them. ADO.NET resolves data accessing to several use separated or tandem discontinuousness use module effectively from the data manipulation. ADO.NET contains the data supply procedure, which is used to connect to the database, execute orders and retrieve results. It can process the result directly or puts ADO.NET Dataset object in it, in order to combine with the data comes from many sources or the data dealt with long-distance processing between the layers, open to the public in a special way. ADO.NET Dataset object may also be independent of the NET Framework data supply procedure when used, in order to manage the local data of application procedure and the data comes from the XML. The source procedure is listed in the addenda.

Structure and function of the database

Structure of database

The database system is mainly composed of data edition module, data query module, electronical plat query module, printing module, adding module and exit module.

Data edition model

Complete data on-line input, including the data input under the editing mode and special batch datum input, and realize amendment and maintenance to the data which has been kept in the archives.

Data query module

It provides the method to pick-up the data which has been brought into line with the management for the user, including the date inquiry, distribution position inquiry, map inquiry and the free condition inquiry.

Electronical plat query module

Shandong Province county map used GIS, which not only can inquire some county alien species, but also can know some external kind of concrete distribution situation, and these data can renew if necessary.

Printing module

This module is mainly used in completing to the database output, including the page setup, the printing preview and printing those three kinds of functions. In the design, in order to be universal, the printing driver should be inputted by users.

Adding module

This module includes two newly built and open functions. In the Visual FoxPro system main menu, it contains the menu which can realize these two kind of functions, we can insert it to the application system main menu using the VFP6.0 menu design insertion function when to design, realizes FoxPro document such as the table, report forms which is needed for the database increase.

Exit module

This module function finishes the event circulation to return to the Windows condition

Function of database

Besides the realization of data inquiry, input, revision and so on, the maximal characteristic of this database system is the union with the GIS.

"Spatial visible, the spatial guidance, the spatial thought" are the three main functions of GIS. Spatial visible can have a direct-viewing feeling to the spatial thing, and may have a vision of the attribute data of the things. The spatial guidance has provided a convenient method, which may find the data what you want quickly, using the map zoom and roam of GIS, which is resembled to move the database inquiry on the map. The spatial thought was in the data foundation which has already used the relational model between the data and the specialized mathematical model. It carries on analysis of spatial distribution and development tendency to assigned environment essential, unifies the GIS formidable function to the database management system of external species, might conveniently realize the data spatial inquiry, the spatial analysis and spatial vision, the user through the friendly man-machine contact surface, sends out each kind of instruction to the system. The system main frame procedure carries on the explanation to these orders, transfers the corresponding processing module to complete the inquiry and analysis operation.

This system makes the inquiry of database visible. The user data choice may demonstrate on the digital map, through the enlargement and reduction of the map, the user simply has realized to the data search scope choice. The user may not only inquire the information which is interested in the map according to the way which chooses through the mouse, but also may have a inquiry through SQL language which is produced by user-defined creator, the inquiry result may print by the report form way.

The main pages

The home page included the following content: realizing the browsing and the simple search of all species on the page, including the entrance link of senior search and input information, inputting any word which is hoped to search in the simple search frame, using Chinese or English at will and selects the fuzzy search method that the aim species will be searched without in-

putting the full name of species.

Besides this, there are pages of species information, classified information, species distinction characteristics, distribution and spatial information, invasion harm and prevention, query by attributes, adding and revising of species information, logging in information and so on respectively in the database.

Realizations of database security

For any Web procedure development, the secure question is not allowed to neglect. This is decided by Internet own characteristic. This database establishment is not exceptional.

Because this database is a sharing database, the secure question is concentrated in the database content and could not be revised arbitrarily. In order to prevent the user from bypassed landing directly without registration to revise the page, we might use the Session object to carry on the registration confirmation. The biggest merit of the Session object is that it can retain user's related information and lets the following homepage to be read. Thus, if bypassed landing contact surface, the Session object cannot be established as through the confirmation condition, is unable to enter the related page behind, which has guaranteed the jurisdiction confirmation security. The page logging in has already been listed in previous.

Data statistics

This database includes 644 alien species information, 133 sheets of species pictures. Of which there is 544 kinds of plants (357 general plant species, 39 potential harmful plant species, 148 harmful plant species), 84 animal species, which including 11 potential harmful animal species and 73 harmful animal species, and 16 microorganism species. There are 494 species existed or once discovered in Shandong Province.

Discussion and suggestion

This catalog database has established initially, and compiled the page realizing the function of browsing, retrieval, addition, revision etc. The information of alien species in Shandong Province in existing literature has been inputted the database. The species picture and species distribution picture may be putted in easily. This had achieved the goal planning in advance. The basic frame of the database has been accomplished, but many species information in this database was not integrated, we have many jobs to do in the future.

Now, the database application system can provide information query service for gov-management department, researcher engaged in introducing propagation, environment constructor and society manager. It is essential to the government decision, introduction, utilize and protection of plant resource, it is feasible in technology too. The establishment of the system provides reference model for the establishment of alien species resource data in Shandong province. The research emphasizes on the establishment of basic information database of alien specie'. There are two aspects, which are needed to solve more of the system design research. First, the development of database should be combined with RS, GPS and GIS, the dynamic information service system of alien species resource in Shandong province should be established, to realize the systemic, synthetical and durative track research of alien species in the whole province or

a certain area, providing alien species service to the gov-management department and other user duly, roundly and true. The information is variable and developmental not immobile and eternal, so the system should be renewed and vindicated in time to vindicate the durative of the system. Second, we may use Visual FoxPro6.0 which is added in web in the future, which makes FoxPro as search engine of application to establish a WWW server on the Internet. It is used for information exchange and share, for doing service to government information network.

The digitization is a very popular topic; the existing database inquiry language has approached the normal language (English), which made the classified statistics searches simple and convenient, but there are shortcomings according to the existing information and database. That is, firstly, database structure is not standard; secondly, resources seal and thirdly, the use is not nimble. In order to boost construction course of data sharing practically, the related department should pay attention to the following aspects of content: Classified code and metadata national standard should be determined as soon as possible, don't have discussion without decision; if the standard is not decided, then each kind of construction of metadata base is belonged to exploration character, the correlative construction of society drive mechanism will impossible to mention, the public participation enthusiasm will not be activated; evaluative policy should be adopt to the consummation of standard, revises and consummates gradually by a all participation metadata standard committee through the way of consulting together; the metadata tool software should be revised and issued together by a certain organization commissioned by the metadata standard committee.

It is not enough to establish the database depending on few peoples, we need more peoples joining in to collect and consummate data, this is a project spanning botany, zoology, microbiology, ecology, agriculture and computer etc. Internet has offered a platform for our working.

Alien species have already caused enormous influence on ecological environment and economic development of our province even our country, so we should entreat the alien species from two aspects defending and management. In the management aspect, we can take several measures, such as biological control, chemical control, integrated pest management, substitute control, ecosystem management, ecological control, etc. (Liang *et al.* 2005). However, the related departments should do more research to the species while introducing, prevent trouble before it happens, which is a more positive and more effective measure to the alien species (Liang *et al.* 2005; User 1998; Venette *et al.* 1998; Wan *et al.* 2002; Zhong *et al.* 2004).

The database has provided very great help for our prevention work, made us recognize the harmful alien species convenient and gained some information of biological characteristic to it. With the help of database, we can also use the experience and lesson which other areas introduce a fine variety for reference. It is believed that today, Internet is developing at full speed, with the help of database system, the prevention and cure of alien species will make new progress definitely.

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